5. This fungus when inoculated in pure culture, either as spores, mycelium or infected wheat tissue, on the unwounded lower internodes of wheat seedlings in moist chambers produced a condition of disease indistinguishable from foot-rot as it occurred in the field.

6. Plants thus inoculated when placed in a moist chamber soon bore numerous spores of the fungus.

7. Wheat planted in soil in pots or benches with an inoculum consisting of this fungus, either as spores or as a pure culture on wheat, developed typical foot-rot.

8. Wheat when planted in infested soil in the greenhouse developed typical foot-rot and when placed in a moist chamber bore the same fungus found so constantly in association with the disease in the field.

9. The fungus in question is a typical *Helminthosporium* as the genus is now understood. It grows luxuriantly on wheat agar, corn meal agar and numerous other media and on autoclaved leaves or stems of various cereals. The spores, observed as grown on autoclaved wheat leaves or stems in humid air, are from 24 to 122 μ long, the majority of them falling within the limits 80–90 μ with septa or pseudo-septa varying from 0 to 13, usually about 5–10. The spores are typically thickest in the region about midway between the base and the middle point of the spore, approaching a narrow or broadly elliptical shape, tapering somewhat toward each end. They possess an outer dark wall that is thin and extremely fragile and an inner, colorless, thick wall that is frequently soft, gelatinous. Both of these characters of spore wall seem to be common in several other species of *Helminthosporium*. The spores usually, perhaps always, germinate either from one or both ends, not laterally, and are functionally one-celled.

Further discussion of the morphological and histological features and the relation of this *Helminthosporium* to other species common on cereals will be presented later.

All of the above refers solely to foot-rot as observed and studied in material originating in Madison Co., Illinois, or cultures derived from such material.

It is to be noted that this cereal disease, while of the general type of foot-rot known heretofore in Europe, Australia and elsewhere, is caused by an organism not heretofore designated as a cause of foot-rot in any of the publications on foot-rot in such countries.

The foot-rot found in Illinois, therefore, should be recognized as a disease quite distinct from all others of similar type that have been described previously. It is clear from experimental evidence that it is soil-borne and it is probable that it is also seed-borne. How serious the disease may prove to be, how dependent upon environmental conditions of climate and soil, can be told only after one or more years of additional observation.

F. L. Stevens

University of Illinois,

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION E—GEOLOGY AND GEOGRAPHY

A Biochemical theory of the origin of Indianaite: W. N. Logan.

Our decreasing natural gas supply: J. A. Bownocker. A study was made of the natural gas supply from the records of four large companies in West Virginia, Pennsylvania and Ohio. It was shown that the open flow of new wells in West Virginia has decreased 79 per cent. in 10 years; in northwest Pennsylvania 70 per cent. in 7 years, and in southwest Pennsy'vania 12 per cent. in 10 years. Changes in rock pressure of new wells are similar. Thus in northwest Pennsylvania there has been a decrease of 37 per cent. in 7 years, and in southwest Pennsylvania a decrease of 34 per cent. in 10 years. In the northern half of West Virginia there has been a decrease of 38 per cent. in the same period. Naturally there has been a proportional decrease in the rock pressure and open flow of all wells. In Ohio the drilling of new territory has kept the averages at a higher figure, but in spite of this the production of gas in the state is decreasing. Ohio gets 60 per cent. of her supply from West Virginia; Pennsylvania about 33 per cent.; Kentucky about 75 per cent., while Maryland and Indiana each draw on the state in a limited way. Manifestly the future supply depends largely on West Virginia. For the two years closing June 30,

1919, the production of natural gas in that state decreased 20 per cent.

Some characteristics of the Balcones fault zone in Bexar county, Texas: E. H. SELLARDS. The Balcones fault zone lies at the inner margin of the Coastal Plains of Texas, and the scarp resulting from the faults is a conspicuous topographic feature which in several counties separates the coastal plains from the high plains of the interior. The fault scarp is most pronounced in Uvalde, Medina, Bexar, Comal, Hayes and Travis counties. The formations observed to have been affected by these faults are those of the Lower and Upper Cretaceous and Eocene, while the Pleistocene formations have not been observed to be affected by faulting. Hence the age of the faults may be between Eocene and the Pleistocene. The number of faults within the fault zone as developed in Bexar county can scarcely be estimated. A few are seen at the surface; a number of others are located by well records, but with little doubt there are many more faults than have been located by either of these methods. They are normal faults with the downthrow to the south in most cases. The faulting is accompanied in some places by gentle folding, and the small oil fields of this county are found apparently upon structurally high areas produced by a combination of faulting and more or less folding. The width of the zone of faulting approximates 25 miles, and yet it remains to be determined how much farther to the south or southeast faulting in this zone may be detected.

The Ozarkian of Missouri: E. B. BRANSON.

The nature of Beatricea undulata: W. H. SHIDELER.

The possibility of a relationship between crystal types and the mode of occurrence of minerals: W. A. TARR. Along with other lines of research on the origin of crystals, the question arises as to whether the mode of occurrence shows an influence upon the type in which a given mineral crystallizes. If physical conditions influence the molecular arrangement this should be the case. A study of 128 common minerals, classified into eight zones shows that there is only a very general influence. The influence of composition appears to be more marked. The higher classes of symmetry are the most abundant in certain zones, yet physical factors do not appear to control the class of symmetry of a mineral. In large groups the physical conditions appear to be a factor but it is questioned whether the chemical factors are not of vastly more importance in these same zones.

An analysis of the process of thrust-faulting: T. T. QUIRKE. It is probable that there is so sharp a zone of division between the surficial plastico-frangible crust and the interior plastico-rigid mass that the part subject to rupture may be considered a separate member even though flow deformation may extend beneath it. Earth stresses due to the adjustment of a plastico-frangible crust to a shrinking interior affect members as wide as the continents and oceans are broad. These members fail near the ends under a stress which is rotational and unequally transmitted throughout the length of each member. The members fail after flexure somewhat in the manner of long columns. This type of rupture combined with a rotational stress makes a strong tendency to rupture at angles low at depth and high near the surface. Immediately after rupture a geologic process of abrasion comes into play. Abrasion is greatest where friction is most intense, at the steep parts of the fault plane. This movement of millions of tons of rock passing several miles along the fault plane will abrade the steep part of the plane to a lower angle and project to the surface the original low angle break. From which it follows that there may be a relation between the steepness of angle and the amount of displacement after rupture.

The mechanical interpretation of joints: WALTER H. BUCHER. On Mine Fork, Magoffin county, Ky., at the crest of an anticline in the upper third of a thick sandstone formation exposed in nearly vertical cliffs, two systems of joints are seen intersecting at an angle of approximately 120°, which is bisected by the horizontal direction. In this case, undoubtedly the joint planes, representing planes of shearing, were formed by simple tension and were arranged in such a way as to have the direction of maximum tension bisect the obtuse angle. In 1896 the French engineer Hartmann published the results of extended experimentation on the planes of shearing in metals, in which he found that the angle formed by the yield planes differs the more from 90° the harder and the more brittle the material is, and that the direction of maximum tension bisects the obtuse angle while that of minimum tension (generally negative, *i. e.*, compression) bisects the acute angle. O. Mohr, in 1900, gave a mathematical theory to account for this behavior. The author demonstrated the usefulness of this relation in interpreting the stress conditions underlying the fracturing of materials in well-known tension, compression and torsion tests. He then proceeded to apply this method to a number of joint systems taken partly from liter-

ature and partly from his own field observations, illustrating the three possible types of joint systems (1) max. tension = horizontal, min. tension = vertical (weight of overlying beds); (2) max. tension = horizontal (anticlinal bending), min. tension = horizontal and at right angles together (synclinal bending); and (3) max. tension = vertical (upward relief), min. tension = horizontal.

Notes on concretions: W. A. Tarr. Concretions found in a black shale of the Pennsylvanian in Boone county, Missouri, are believed to be syngenetic in origin. Reasons for so believing are the composition of the concretions (mainly clay and silica), the arching of the beds over them, absence of stratification lines passing through the concretions, lack of evidence of lateral crumpling, slickensides due to the consolidation of the beds around the concretion, and the volume of the concretions.

The Devonian of Ralls county, Missouri: Gilbert P. Moore.

Notes on the coal industries of northeastern France, Belgium, the Saar District and Westphalia: H. F. Crookes.

Data gathered by the writer for the War Damages Board of the American Commission to Negotiate Peace, in Paris, on the coal industry of western Europe, shows, among other things, that, of the reserves of coal, Germany now controls 28 per cent., England 49 per cent., France 7 per cent. and Belgium 4 per cent.

The acquisition by France of the Saar district does not solve that country's future requirements of coking coal for her Lorraine iron ore, because of the fact that it is impracticable to smelt the ore with Saar coke unless it is mixed with about 20 per cent. of Westphalian or equally good coke. Taken alone, Saar coke has been found to have about 67 per cent. the efficiency of Westphalian coke.

With the opening up of the Campine Basin in Belgium, France will be able to reduce her coke imports from Westphalia, but, even so, she must rely on the latter district for her principal supply of blast furnace coke.

Aside from a gain in actual coal reserves of over 16 billion tons, it is estimated that the net monetary gain by the acquisition of the German interests in coal lands, mines, equipment and coke plants in the Saar district is 411 million francs.

The dependence of the French and Belgian metallurgical industries on Westphalian coke is offset by the former's control of iron ore, for France now controls about 85 per cent. of the iron ore reserves of Europe. It has been advocated that a portion of the German indemnity be paid annually in terms of Westphalian coke. This would permit of the entire domestic coal production of both France and Belgium being diverted to industries other than metallurgic, but at best would be only a temporary arrangement. The exchange of iron ore for Westphalian coke, arbitrated by a committee from each country, might be a better solution, and is one that has been recommended.

The influence of the differential compression of sediments on the attitude of bedded rocks: Maurice G. Mehl. The diminution of the height of a column of sediment upon consolidation is brought about chiefly by the loss of water through the weight of the column. The rate of compressibility for shales is greater than for sands because of the differences in the shape of the particles. In the plate-like particles of shale there is a larger surface and hence a greater separating water film per unit volume of shale. The compressibility of sand is very slight while for shale it may be as high as 20 per cent. It follows that any difference in the total thickness of types of sediments with different rates of compressibility in adjacent columns will impart secondary dips to all beds above the irregularities. Unequal thicknesses of totals may arise through the lateral gradation of one type into another or through the actual thinning of a bed of a given type. Likewise any irregularity on an unyielding depositional surface will tend to produce different totals in the overlying columns of sediments. While the small isolated dome-like anticlines typical of the Mid-Continent oil field may have acted as localizing influences for the expression of later thrusts acting through great distances it is thought that these small structural features are chiefly the result of the differential compression of sediments.

Compression of sediments as a factor in the formation of coal basins: E. B. Branson.

On the Pennsylvanian stratigraphy in the mid-continent region: R. C. Moore.

Episodes in Rocky Mountain orogeny: C. L. Dake. West of Cody, along Greybull and Shoshone Rivers, are a series of yellow sandstones and red and gray shales with conglomerate layers. The conglomerates, which include granite pebbles, involve erosion down to the pre-Cambrian, and the beds rest with slight angular unconformity on the Cody (Niobrara and Pierre) shale. These conglomerates are themselves folded and are involved in large overthrust faults. This implies two epi-

sodes of deformation, one before and one after the laying down of these beds. The conglomerates are tentatively correlated with the Fort Union, as that formation is described by Hewett and Lupton in recent papers. These workers also recognize two episodes of disturbance, quite probably the same two noted by the writer. One they place as post-Lance and pre-Fort Union, the other as post-Fort Union and pre-Wasatch. If their correlations are correct they find both episodes of diastrophism to be post-Lance. This appears to be contrary to the idea of Knowlton and others who point very definitely to a pre-Lance (pre-Arapahoe) period of folding. We must conclude, therefore, either that the so-called Lance and Fort Union of the Big Horn Basin, as the terms are used by Hewett and Lupton, are not the equivalents of the Lance and Fort Union described by Knowlton, or else we must conclude that there are three episodes in the orogeny of the Rocky Mountains, one pre-Lance and two post-Lance.

The present status of the Pleistocene in Illinois: MORRIS M. LEIGHTON. Detailed studies on the Pleistocene in Illinois, begun in 1886 under the supervision of Professor T. C. Chamberlin, led to the publication in 1899 of Monograph XXXVIII. on "The Illinois Glacial Lobe," by Mr. Frank Leverett. Aside from certain obscure problems which were left for further study, two important questions have since arisen from changes and shifts in the classification of American drift-sheets. When the verity of the Iowan epoch was questioned, subsequent to the publication of Monograph XXXVIII. the Iowan drift in Illinois was discarded. Since then, the area has been referred to the Illinoian stage, then to a substage of the Illinoian, and still more recently a considerable portion has been suggested as being possibly Early Wisconsin. Whether the drift in northwestern Illinois is wholly or in part Illinoian, Iowan or Early Wisconsin remains to be determined by critical and comparative field-work. The Wisconsin drift deposits were divided into two major drifts in Monograph XXXVIII. but later were reduced to two subordinate stages, and more recently a suspension of the sub-stages "Earlier" and "Later" has been proposed. An early critical study of the drift of northwestern Illinois and of the basis of classification of the Wisconsin drift-sheets is contemplated.

A possible factor in the origin of dolomite: W. A. TARR. It is believed from the study of the areal and time distribution of dolomite that its origin is directly dependent upon shallow continental seas, or lakes, for the necessary concentration of magnesium salts in sufficient amounts for its formation; that the deposition took place upon the sea or lake bottom; that in such seas or lakes we have an adequate source of magnesium; and that such a mode of origin is compatible with the interbedding of dolomite with limestone.

Some glacier studies in Alaska: ROLLIN T. CHAMBERLIN. The ultimate purpose of these studies was to obtain a better understanding of the true nature of glacier motion. Some of the more immediate purposes were to demonstrate movement along definite shear planes which would indicate brittleness and rigidity of materials; and also to determine what relation there might be between the rate of shearing and the temperature, time of day, daily range of temperature, amount of water entering the ice, and variable meteorological conditions. This investigation was undertaken by means of a self-recording clock-work apparatus which was attached to two rods driven into the ice, one above the fracture plane to be investigated and the other below it. The apparatus was sensitive to shearing amounting to as little as one hundredth of an inch. Many difficulties were encountered and only indifferent success achieved. Such records as were obtained seemed to indicate that shearing was more rapid between 6 P.M. and midnight than between 6 A.M. and noon. This would not be at the time of greatest melting but lagging after it. It would be when there was the most water in the ice. A study of the "sloughing off" of Child's Glacier and especially the relation between the shearing planes and the blue bands constituted an important and critical part of the investigation.

The stratigraphy of the Chester series of southern Indiana: CLYDE A. MALOTT AND J. D. THOMPSON, JR. The following is the first attempt to give the entire detailed stratigraphy of the Chester Series of Indiana, using the names adopted by the Kentucky and Illinois surveys and by the writer in a former publication:

BUFFALO WALLOW Formation	Siberia ls. at base, 1–12 feet; overlaid by some 60 feet of sandy sh. and a thin ls.
TAR SPRINGS Formation	Massive ss., 0–75 feet, and sh., 50–125 feet; thin impure limestones in shale when ss. is absent or thin.
GLEN DEAN Limestone	Massive, often oolitic limestone; 10–45 feet.

Hardinsburg Sandstone	Hard, flaggy ss., with some sh. above and below; 25–40 feet.
Golconda Limestone	Bedded to massive ls., often oolitic; contains chert; and frequently thin sh. bands; 0–40 feet.
Indian Springs Shale	20 feet of olive sh. characteristically underlies the Golconda limestone.
Cypress Sandstone	Massive, laminated, friable, yellow ss.; 25–45 feet.
Beech Creek Limestone	Bedded to massive, compact ls.; 8–25 feet.
Elwren Sandstone	Ss. not persistent; the interval often entirely sh.; 15–60 feet. Local unconformity at the base.
Reelsville Limestone	Compact to oolitic, pyritiferous; wethers red; one ledge at north; some sh. at south; 0–12 feet.
Brandy Run Sandstone	Massive to bedded ss.; usually some sh. above and below the ss.; 10–65 feet. Local unconformity at base.
Beaver Bend Limestone	Bedded to massive, cream-colored, usually oolitic ls.; 2–20 feet.
Sample Sandstone	Usually massive and accompanied by sh.; interval frequently all sh.; 10–40 feet.
	MITCHELL LIMESTONE GROUP
Gasper Oolite Limestone	Compact to oolitic ls., 15–40 feet. Lower Gasper of K Major unconformity at base. Bottom of Chester following Weller.
Fredonia Oolite Limestone	Compact, lithographic and white, finely oolitic ls.; 60–80 feet. Major unconformity at base. Bottom of Chester following Ulrich.
St. Louis Limestone	

The correlation of coal seams by means of spore-exines: Reinhardt Thiessen. On microscopic examination of sections of different coal seams it is readily seen that each seam presents certain appearances and certain constituents that are common to all sections from the one seam but which differ in some respects from those in any other seam. The spore-exines in particular have very definite and clearly defined characteristics, such as form, size and sculpturing by means of which different kinds can easily be distinguished from one another. These spore characteristics have been so well preserved in almost all coals that the spores of one species of plants can be clearly distinguished from those of other species. In examining the spore-exines of a number of sections of one seam, it is soon found that by far the larger bulk of the spore-exines of that seam are often very largely of the same kind. In some, two kinds, while in others, three kinds of exines may form the main bulk. In comparing the predominating exines of one seam with those of another it is not difficult to see that those of one bed are different in some way from those of any other. Occasionally there will be found in a given coal seam a spore-exine that differs materially from those found in other seams. This spore-exine is a distinguishing characteristic of the coal seam in question but not in general the predominant one. As is the case in the peat forming bogs of to-day, where each bog or series of bogs contains one, two or three species of plants that predominate, so in the peat bogs of the Coal Age, each bog giving rise to a future coal seam must have contained one, two, or three, sometimes perhaps more, species of plants predominating in that bog and differing from those of bogs of any other time or perhaps locality. There are sufficient grounds for the broad statement that, as far as they have been examined, each coal seam contains one or more kinds of spore-exines that are predominant and characteristic, or if not predominant, are at least characteristic of that seam. By this means any seam may readily and easily be distinguished from any other.

Climate and geology: Stephen S. Visher. It is being increasingly realized that a knowledge of climate is very helpful to geologists. (1) In order to understand differences in weathering, erosion, transportation and deposition, climate and its differences must be understood. (2) Paleoclimatology, or the study of the climates of the geologic past is an important aspect of historical geology. Several very eminent geologists have studied ancient climates and the influence of climate and have enriched the science of geology greatly by so doing. They have urged further study of this by no means exhausted subject. Davis, Barrell, and Huntington have contributed much to an appreciation of the importance of climate in physiography and sedimentation. Schuchert has given the best summary of the climates of geologic time. Cham-

berlin (T. C.) was led by his study of glacial climates to formulate several hypotheses which have done much to advance geology (see "The Origin of the Earth"). The recently published work of Ellsworth Huntington concerning changes of climate is of notable interest to geologists. The data he has accumulated and the stimulating hypotheses he has advanced to interpret these data are worthy of most serious consideration. The importance of climate and the promised fruitfulness of its study has led the speaker to attempt to facilitate its study by summarizing what is known as to climate under the title "Laws of Climate." This summary will be published soon in *The Monthly Weather Review.*

A notable case of successive stream piracy in southern Indiana: CLYDE A. MALOTT. This paper deals with the Knobstone cuesta region lying between the Muscatatuck and Ohio Rivers near the eastern margin of the driftless area of southern Indiana. Its purpose is to show specifically the responsibility of the geologic structure and topographic condition in drainage adjustment. Details shown how the particular lithologic units with their regional westward dip are important conditioning factors in giving rise to topographic forms. Other conditioning factors scarcely less important are the so-called time factors, such as various uplifts, rejuvenation and glaciation. The peculiarity of the streams flowing east from the Knobstone escarpment is noted. Blue River with its peculiar unchanging gradient is discussed in some detail, as it is representative of all the streams on the backslope of the cuesta. It is shown that the piracy of the Muddy Fork of Silver Creek has taken place as a result of the geologic structure and topographic condition along the Knobstone cuesta. It is not a single instance of piracy, but consists of successive piracy wherein a large number of tributaries belonging to a single system have been annexed one after another to the drainage system of the invading stream. Some 35 square miles have been stolen. The conditions are highly favorable for piracy to continue, and eventually the largest part of the Muddy Fork of Blue River will be taken over by the Muddy Fork of Silver Creek. Such piracy will continue until a balanced condition of the gradients of the two stream systems is reached. Such a condition will mark the beginning of old age of the stream systems, when stream adjustments are practically complete.

The Satsop formation and structure of the Cascade range: J. HARLEN BRETZ.

Geotectonic economy of thrust-faulting: CHARLES R. KEYES.

ROLLIN T. CHAMBERLIN,
Secretary

THE AMERICAN MATHEMATICAL SOCIETY

THE two hundred and tenth regular meeting of the society was held at Columbia University on Saturday, April 24, extending through the usual morning and afternoon sessions. The total attendance exceeded one hundred and thirty and included eighty-two members. President Frank Morley occupied the chair, yielding it to ex-President R. S. Woodward during the presentation of the papers on relativity at the afternoon session. The Council reported the election of the following persons to membership in the Society: Professor H. S. Everett, Bucknell University; Dr. J. L. Rouse, University of Michigan; Professor Nilos Sakellariou, University of Athens; Mr. H. L. Smith, University of Wisconsin; Professor Eugene Taylor, University of Wisconsin; Professor W. P. Webber, University of Pittsburgh. Thirteen applications for membership were received.

Professor L. P. Eisenhart was reelected to the Editorial Committee of the *Transactions,* for a term of three years. Professor P. F. Smith will retire from the Editorial Committee on October 1, after nine years' service as editor, and Professor G. D. Birkhoff will fill out Professor Smith's unexpired term. Professor Oswald Veblen was appointed a representative of the society in the Division of Physical Sciences of the National Research Council for a term of three years. Professor Veblen's Cambridge Colloquium lectures on Analysis Situs will be published by the society in the fall. Committees were appointed to confer with a committee of the Mathematical Association on joint plans for future meetings and to prepare nominations for officers for the annual election next December.

On the recommendation of the Council it was unanimously voted to incorporate the society under the membership corporations law of the state of New York. The new form of organization will involve hardly any changes beyond those necessary to comply with legal requirements. The board of trustees will be composed of those members of the Council who are elected by the society, the ex-officio members not being eligible as trustees. Otherwise the constitution and by-laws, which have come down from the beginnings of the so-